DOCUMENT RESUME

ED 237 695 CE 037 649

AUTHOR Grosvenor, J. S.
TITLE Technology and the Department of TAFE. Dimensions, Options and Strategies. Occasional Papers.
INSTITUTION National TAFE Clearinghouse, Adelaide (Australia).
PUB DATE Mar 83
NOTE 62p.
PUB TYPE Viewpoints (120)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Foreign Countries; *Government Role; Institutional Role; Postsecondary Education; *State Departments of Education; *Technological Advancement; *Vocational Education
IDENTIFIERS *Australia (South Australia)

ABSTRACT

These three papers outline the technological issues confronting the Department of Technical and Further Education (TAFE). The first paper describes the technological dimensions of the Department of TAFE. It establishes the role of technology within the department and the four avenues through which the department influences the technological future of South Australia: as a user of technology, as a developer of technology, as technological trainer and educator, and as a selective promoter of technologies. The second paper outlines local and international trends in industry, employment, and technological changes that provide cues for the department's response to technological change. The effect of technological change in TAFE is discussed in three contexts: the socioeconomic, the industrial structure of the work force, and the occupational structure of the work force. Special attention is given to approaches to vocational education and training. The third paper suggests ways in which an association between the Department of TAFE and the Ministry of Technology might profitably be forged. Major tasks confronting the department and relating to the ministry are outlined, after which some functional relationships between the two parties are proposed. (YLB)

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TECHNOLOGY AND THE DEPARTMENT OF TAFE

DIMENSIONS, OPTIONS AND STRATEGIES

OCCASIONAL PAPERS

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March, 1983

DEPARTMENT OF TECHNICAL AND FURTHER EDUCATION, SOUTH AUSTRALIA
A RESEARCH BRANCH PUBLICATION

CE037649

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TAFE CLEARINGHOUSE ACCESSION NUMBER S.A. 7-6
DEPARTMENT OF TECHNICAL AND FURTHER EDUCATION , SOUTH AUSTRALIA , MARCH 1983

PREFACE

In the Department of Technical and Further Education (TAFE) technology and technological change are more than academic concerns. They are embedded in the Department's purpose - its role as the South Australian Government's major instrument for providing education and training to the State's youth and adults. Education about technology and training in technical skills are central elements of this brief. Furthermore, technology itself is a means to this end.

The three papers together outline the technological issues confronting the Department. They have a two-fold purpose:

- to continue discussion and analysis of technological change within the Department, following on from the occasional paper on this topic by Swain and Cappo (1980)*.
- to explore possible relationships between the Department of TAFE and the new South Australian Ministry of Technology.

The position developed throughout the papers is based firmly on this proposition:

> Of the instruments of the South Australian Government the Department of TAFE is one of the most strategically placed to influence the direction and effects of technological change in South Australia.

This proposition does not imply that the Department's most effective contribution can be made in isolation from other governmental, industrial and broader societal initiatives. In any circumstances technological change not only presents the Department with crucial opportunities for enhancing the quality of life of South Australia, it also presents challenges of great complexity and difficulty.

The papers address three topics:

- the technological dimensions of the Department (Paper No. 1)
- local and international trends and lessons which together signal options for the Department (Paper No. 2)
- suggested relationships between the Department of TAFE and the Ministry of Technology (Paper No. 3).

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* R. Swain and J. Cappo (1980), The Effect of Technological Change on TAFE. Department of Further Education, Adelaide.

PAPER NO. 1

THE TECHNOLOGICAL DIMENSIONS OF THE DEPARTMENT OF TAFE

This paper outlines the technological dimensions of the Department of TAFE. It does not evaluate the Department's technological role. It provides instead a descriptive and conceptual base for the task of dealing with technological change - a task taken up in the following papers.

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SECTION 1
INTRODUCTION

This paper describes the technological dimensions of the Department of TAFE. It establishes the role of technology within the Department and the avenues through which the Department can and does cast influence on the technological future of South Australia. The aim is to provide a framework for the subsequent papers which unravel specific problems, prospects and strategies for the Department.

Technology, to use a plain language definition, is the body of know-how, gear and techniques for doing things and getting things done. Technology therefore includes the human intellectual and physical skills, used to produce goods and services, as well as equipment.

From this viewpoint the Department can be seen to perform four main roles related to technology:

- DTAFE as a user of technology
- DTAFE as a developer of technology
- DTAFE as a technology trainer and educator
- DTAFE as a selective promoter of technologies

These roles are discussed sequentially in the following four sections of the paper.

SECTION 2

TAFE AS A USER OF TECHNOLOGY

The Department of TAFE uses technology in each of three elements of its operations:

- curriculum content
- teaching and learning processes
- infra-structure

2.1 TECHNOLOGY IN CURRICULUM CONTENT

Courses, especially the vocational courses, in the Department's programme are designed to provide students with technical skills and knowledge about technologies. The broad specifications of the technological content are established by the formal curriculum development mechanisms which are part of the Department's infra-structure (see section 2.3).

The fine details of the content are fleshed-out by the teachers, either permanent staff or temporary staff.*

2.1.1 COURSES TAUGHT BY PERMANENT STAFF

For most vocational courses the detailed content of the curriculum is derived from the teaching staff who draw on knowledge and skills which they gained mainly through their prior participation in the occupations and industries addressed by a course. Trade teachers, for example, have had several years experience in the trade before they joined the Department.

The technologies employed in industry change over time. The teacher's practice-based knowledge of technology in industry therefore becomes dated.

Therefore to maintain the contemporary relevance of the curriculum the teacher supplements his or her earlier vocational experience through, for example, maintaining professional contacts with industry, drawing on knowledge held by colleagues, and by formal and informal learning activities (e.g. trade literature and staff development workshops).

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* 'Permanent' is used here to denote staff on contract for a year or more, as well as staff with tenure.

2.1.2 COURSES TAUGHT BY TEMPORARY STAFF

For some courses (or topics within them) the Department does not have permanent staff with specialist knowledge and competence in the relevant vocational fields. In these cases the Department draws on outside experts both for the fine detail and to teach the course. Usually the experts are practitioners from industry. They are employed by the Department on a temporary and usually part-time basis.

The telling point is this: whatever the vocational course the technological content to a large extent depends on the technological knowledge of the staff. Even for courses arranged but not taught by them, the permanent staff must have at least an adequate appreciation of the technology addressed by the course so that they can set the course's broad specifications and identify the appropriate external experts.

2.2 TECHNOLOGY IN THE TEACHING AND LEARNING PROCESSES

Teaching entails two overlapping fields of technology:

- general instructional knowledge and techniques (including managerial and interpersonal skills).
- materials and equipment on or through which the student learns the content of the curriculum (e.g. industrial plant or its simulation; printed material; electronic audio-visual hardware and software; chalk-boards; laboratory-type equipment for demonstrating selected principles and their applications).

Technology from both of these fields is in operation during every moment of the teaching and learning that constitute TAFE courses.

2.2.1 FUNDAMENTAL APPROACHES TO INSTRUCTION

The technologies of teaching can be described in terms of at least two fundamental approaches of instruction.

- teacher focussed - the traditional approach of institutional education in the 19th and early 20th centuries. It is symbolised by the teacher at the front of the classroom with regimented ranks of students attentively absorbing knowledge flowing from the mouth of the teacher. As in universities, 'lecturing' is a mode of teaching used for much of the 'theory and facts' in TAFE courses.
- student focussed - the approach that has received widespread emphasis since the sixties. It is symbolised by groups of students working at different rates and possibly on different topics. It can be heavily dependent on instructional materials or on a high teacher-to-student ratio since the teacher acts more as a one-to-one tutor than as a lecturer.

Both instructional technologies are used in the Department, with the balance tilted towards 'teacher focussed'. This tilting of the balance does not derive from lack of knowledge in the teaching force about alternatives or from a capacity to adopt them.

This may have been the situation prior to the early seventies when a large proportion of the Department's permanent teachers did not have professional teaching qualifications; their qualifications were more their previous training for and experience in the vocations which they taught. However, during the seventies the Department and its teaching force jointly tackled the task of equipping teachers with formal, teaching qualifications. In 1977 54% of the teachers held teaching qualifications and 30% were receiving training.

Rather, the bias towards teacher-centred instructional technology can be seen to be a consequence of

- resource limitations which militate against student-centred technology
- the inertia of tradition
- teachers' deliberate choice.

2.2.2 MATERIALS AND EQUIPMENT

The materials and equipment used in the Department's courses can be divided into two categories (although the distinction is blurred for many items):

(a) 'multi-use' materials and equipment - the main technology of which stems from general educational theory and practice. The chalk-board is the traditional example; the multi-use micro-computer is a more recent example. The use of these devices is not tied to courses for one discipline or vocation.

(b) 'single-use' equipment and materials - the main technology of which derives from the vocational field to which the learning will be applied. Plant and equipment used by the industry addressed by a course are the most frequent examples: students learn how to use industrial equipment by practising on the college's equipment.

Traditionally the investment on teaching equipment and material for the Department has been low, falling well short of the requests by colleges. This problem had become particularly acute by 1980, but is now being redressed to some extent by

- increased funding for equipment
- increased attention to joint-use of equipment with industry.

The pressures which the obsolescence of 'single-use' equipment placed on budgets in turn placed the procurement of extensive, 'general' learning devices at lower priority and in effect beyond the Department's reach. Equipment at the forefront of educational technology - micro-computers, audio-visual software, and multi-use industrial simulators, for example - have been the highly visible casualties with obvious ramifications upon the instructional options available to the teaching staff.

2.3 TECHNOLOGY IN THE INFRA-STRUCTURE

The Department's educational programme is sustained by an infra-structure comprising

- administrative and service systems
- accommodation

Both facets of the infra-structure employ technologies.

2.3.1 ADMINISTRATION AND SUPPORT SERVICES

These functions are served by technologies with a predominantly managerial or information-processing character in a wide range of specialised applications, including

- staff recruitment, deployment, development and industrial relations
- finance and accounting
- curriculum development/formalisation
- research and evaluation

The technologies entailed in these functions are predominantly 'human' and 'conceptual' and are manifested as procedures, organisational structures and processes, and the 'disciplines' for generating and maintaining them. Nevertheless a more restricted image of technology - namely hardware - is playing an increasing role in infra-structural systems, e.g.:

- word processing
- computer based statistical systems
- electronic information-searching (linked to international bibliographies and clearinghouses).

2.3.2 ACCOMMODATION

The Department's programme is implemented in or by the network of 27 colleges. The nature of this accommodation is a reflection of the technologies used in the teaching/learning processes, and in the administrative and support services. For example:

- The newly constructed School of Plumbing at Regency Park Community College incorporates in its design various structures and equipment (besides moveable plant etc.) which simulate industrial settings and industrial applications of plumbing and gas-fitting technologies. In this case learning takes place on it as well as in it.

- Contrasting with the special-purpose plumbing facility are the recently approved specifications of a saw-doctoring facility for the South East Community College. It is designed as a multi-use facility serving the related vocational fields of saw-doctoring and fitting and machining.

- In several colleges the accommodation is essentially makeshift. The facilities were not originally designed for TAFE-type applications: they provide 'accommodation' in its most general sense and often do not favour the most modern teaching technologies.

SECTION 3

TAFE AS A DEVELOPER OF TECHNOLOGY

The development of technology by the Department is extensive (but whether it is extensive or intensive enough is quite another matter). This fact is often overlooked, simply because many do not conceive of technology beyond its material manifestations - its electronic, chemical and mechanical hardware. The more systematic (and educationally and industrially useful) view which has been adopted in the previous discussion is that technology comprises not only equipment but also human know-how and 'devices' - techniques, procedures, organisational systems, operating knowledge and skills. This view is essential for an understanding of technology development in the Department.

Like any establishment the Department seeks to optimise the effectiveness and efficiency of its overall and individual operations. Technological innovation is a major means to this end. Some of the advanced technology required by the Department is procured or adopted from elsewhere. Nevertheless technology required by the Department often is not available from other sources and so must be developed internally. This in-house development occurs across the spectrum of functions discussed in section 2. Recent examples include:

- in-house development of a computer-drive system for a numerically controlled milling machine (required as equipment for teaching) by college staff in 1974, before CNC equipment was introduced into South Australian industry.
- development of procedures for establishing and operating the Australia-wide TAFE Clearinghouse system.

Current initiatives include:

- development of a new, Department-wide education and operations management information system.
- development of a micro-computer based management information system for college-level administration by Regency Park Community College.
- development of new procedures for processing curriculum proposals.
- development of a variable speed controller for sewing machines by Marleston College of TAFE.

During the expansionary phase of the Department in the seventies, new technologies frequently were 'bought-in', mainly in the form of newly recruited staff who possessed the required, specialist expertise. Notably, this trend - along with the continual diversion of the Department's attention to new programmes and projects - led to a shortfall in the development of infra-structural and educational technologies within the Department. Furthermore, when there were such developments their document-

ation and dissemination often were so limited that they were not used as a basis for later action on similar matters. A crisis management approach - 'putting out brushfires' - prevailed over the systematic refinement, development and dissemination of operational procedures. Consequently much of the technology introduced into the Department remained in the heads of staff and opportunities for cumulative, system-wide improvements were few or not captured.

The contraction of the Department's budget from the late seventies now militates against this approach. As a rule the operational problems which require technological solutions can only partly be solved by the procurement of expertise from beyond the Department. Therefore, the need for the in-house development of technologies is increasing.

It should be noted that the technologies developed by the Department are those which have been selected for attention because they will or should contribute directly to the effectiveness and efficiency of the Department's own operations. That is, the Department has not been in the business of developing technologies which benefit other industries but not the Department itself.

SECTION 4

TAFE AS A TECHNOLOGY TRAINER AND EDUCATOR

Annually about 15% of the State's youth and adults enrol in courses provided by the Department. (In 1981 the population of people in South Australia over the age of fifteen was 978 500; 134 400 enrolled in the Department's courses.) The Department therefore is a major point of contact between the Government and people of South Australia. The Department's programme provides systematic education and training at all levels other than that of the higher education sector (universities, colleges of advanced education, institutes of technology). It serves the vast majority both of industries and occupations for which vocational education and training is required.

4.1 VOCATIONAL COURSES AND TECHNOLOGY

The vocational courses relate to occupations and the objectives of students in various ways:

- vocational awareness courses (especially transition education courses) assist students to make informed vocational choices. They expose students to the conditions, opportunities and educational requirements for certain vocations; but they do not provide extensive development of skills specific to particular vocations.

- preparatory courses provide students with the general educational pre-requisites for the further education or training that might be required for certain vocations.

- vocational entry courses provide students prior to their entry into certain occupations with the vocation-specific, educational pre-requisites for those occupations.

- vocational-parallel courses, for students who have entered an occupation, provide basic vocational knowledge and skills which they require in order to attain proficiency in their acquired occupation. The courses take place in parallel with the students' employment and can provide the qualifications subsequently required for continuing employment in that occupation.

- extension courses for the student already qualified or experienced in a vocation, renew, up-date, intensify or broaden the individual's vocational skills and knowledge.

Within the courses the curriculum is aimed at providing students with either or both

- appreciation of technology (its nature, its application and its effects) involved in certain vocations.

- competence in applying technology involved in certain vocations; it entails both detailed knowledge about the technology and practical, technical skills.

Technology changes over time. The technological content of the Department's courses therefore can be described in terms of its 'relative level' - how up-to-date and industrially competitive the technology is in comparison with other, probably older, technologies.

Various benchmarks can be used for the comparisons. For the Department's courses the state of technological development within South Australian industry is an obvious criterion, giving rise to the following classification of technological content in a course:

- Sub-standard*: the technology is below (i.e. outmoded) the level of most firms in the South Australian industry.
- Standard: the technology matches that employed in most firms but is below the level of technology in the more advanced South Australian firms.
- Advanced (or Above-standard): the technology is on a par with the more advanced South Australian firms and therefore above the norm in the industry.
- Leading: the technology is ahead of even the more advanced firms in the South Australian industry.

Another benchmark for rating the technological content of the Department's course is the level of technology in firms interstate or overseas - the actual or potential competitors with South Australian industry. In this context South Australian firms and the Department's courses can variously be above, equal to, or below the technological levels of industry beyond the State.

The Department's courses on the balance probably lie around the 'standard' level of technology in South Australia. Efforts to place all vocational courses 'above standard' have not been aided by the rate of technological change and by the low investment in equipment during the late seventies.

While a course's technological content can be given an overall rating compared to industry, it must be recognised that this averaging can belie important differences within a course. Its content, again relative to industry, on some topics may be up-to-date, but in others be obsolete.

4.2 ENRICHMENT COURSES AND TECHNOLOGY

Besides its strictly vocational courses the Department provides 'enrichment' courses. Some of these courses contribute to technology education in various ways:

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* Sub-standard refers here to content, not quality of teaching and learning. In such a course students might gain considerable skill in, say, traditional typesetting technology which has been outmoded in most firms of the printing industry.

(a) 'conventional' vocational uses, (b) 'hidden' occupational uses and (c) non-vocational uses.

(a) Conventional vocational uses (i.e. relating to occupations providing direct financial reward).

Some of the courses enable the student to 'taste' a vocational field without committing themselves to a lengthy, formally vocational course. That is, the course provides opportunities to explore briefly a vocational interest and then to make more informed, 'hard' vocational choices.

Some individuals use the courses to obtain vocational knowledge and skills that facilitate entry to an occupation or extend their proficiency within an occupation. For example, some landscaping contractors treat the 'enrichment' courses, Home Landscape Design and Landscaping, as a minimal pre-requisite for occupations in that industry.

(b) 'Hidden' occupational uses

Jones (1982) among others writes of a large and growing 'quinary' sector in the economy.* He refers to domestic and quasi-domestic activities where individuals sustain or supplement their economic requirements without drawing pay or selling services in the classical economic sense. Do-it-yourself activities and the quid pro quo exchange of produce, time and skills among householders are examples. The Department's current 'enrichment' programme serves this end as these examples of courses indicate: Mud Brick Construction, Spinning and Weaving, Motor Maintenance, Saddlery, Furniture Restoration, and Organic Vegetable Gardening. Notably, these handi-craft type courses tend to focus on 'old' rather than 'new' technologies.

(c) Non-vocational uses

Some enrichment courses provide the student with an appreciation of a new technology or the social impact of technology, e.g. Word Processors - a New Technology, Introduction to Computers, Hydroponic Gardening. These courses (a small proportion of the enrichment programme) provide one medium for increasing the individual's capacity or propensity to participate in informed, community decision-making on technology-related issues and to make more informed decisions on personal, technological issues.

* B. Jones (1982), Sleepers, Wake: Technology and the Future of Work, Oxford University Press, Melbourne.

SECTION 5

TAFE AS A SELECTIVE PROMOTER OF TECHNOLOGIES

The Department casts its influence on technological developments in South Australia in three main ways:

- through its consumption of goods and services
- through the diffusion of technologies, developed by the Department, into the public service and education industries
- through the systematic provision of technological knowledge and skills to the students in its courses. This service is the Department's most powerful influence on technological development.

5.1 CONSUMPTION OF GOODS AND SERVICES

The Department is a consumer of technologies - directly or through the technologies inherent in procured goods and services. The Department's capital works and equipment budgets were respectively $14 million and $2 million for the 1982/83 year. The selection of goods and services within this procurement programme has clear economic and technological implications beyond the Department itself, especially if the selection is consistent throughout the education and public service sectors.

The overall balance between orders and contracts let out to South Australia as opposed to interstate and overseas industries can be considered as an expression of State Government economic policy.

Perhaps more important in terms of technological development is the fact that procurement from South Australian industry selectively lends market-place support to some firms and to some industries. Inadvertently or deliberately this pattern of procurement constitutes a Departmental or, more broadly, State Government policy favouring those technologies represented by the Department's suppliers over alternative technologies used or marketed by their competitors.

The procurement of goods and services by educational institutions can have a multiplier effect. Students who become familiar with a technology, product or even brand-name during their courses can carry a predilection for that technology, product or brand into their working lives or their patterns of personal consumption. Firms recognise this effect, as this example shows:

> Apple has offered to donate one computer to every public school in the US - a total of 80 000 computers worth $200 million retail ...
> (Time, 3 January 1983, p.13)

5.2 TECHNOLOGIES DEVELOPED BY THE DEPARTMENT

The technologies developed by the Department were discussed in section 3. These technologies, it was noted earlier, serve first and foremost the effectiveness and efficiency of the Department's internal operations. Nevertheless the Department - as a 'firm' at the crossroad of the public service and education industries - can make its own technologies available to agencies and firms within those industries.

An example of this role is the Department's development of TAFE clearinghouse technology. In the mid-seventies the Department developed and implemented a system for collecting, storing and disseminating TAFE publications in South Australia. The principles, techniques and procedures developed for this project were extended into the subsequently developed National TAFE Clearinghouse system which is currently operating across the TAFE authorities of the eight states and territories and is linked directly to other information systems in Australia and internationally (AUSINET, DIALOG and ERIC).

It is stressed, however, that the technologies developed by the Department are in general not of types which can be adopted by industries outside the public service or education industries.

5.3 THE EDUCATIONAL PROGRAMME

The dominant influence of the Department on the technological and socio-economic fabric of South Australia lies in its educational programme. In the industrial field the supply of skills and knowledge to the workforce can be a limiting factor in production using the existing technologies. It can also be a means of stimulating or facilitating technological innovation which in turn affects the quality, quantity and efficiency of production.

To gain an understanding of the ways in which the Department casts this influence, it is useful to examine the major variables in the educational equation for a course's impact on its clients - particularly the individual student and industry. The variables, shown in Table 1, can be divided into two groups:

- curriculum variables
- operational variables

5.3.1 THE CURRICULUM VARIABLES

The variables in this group refer to the nature of skills and knowledge that are the intended learning objectives of a course:

- The target industry. The content of the vocational course is directed towards vocational applications in one or more industries.

- The target occupation(s). The content of the course is directed towards one or more occupations. The curriculum might be directed at the most general level towards 'paid employment' or, at the most specific level, towards a particular position in one firm.

- The vocational objectives. The curriculum is intended to serve the student's vocational objective (listed in section 4) such as vocational awareness, or vocational entry.

- The technological learning objectives. The learning objective is the acquisition of an appreciation of or competence in the technologies addressed in the curriculum (see section 4).

- The standard (level or type) of technology. The standard can be described in terms of its relationship with technologies in South Australian industry and consequently with technologies in industry elsewhere (see section 4).

- The effectiveness of the curriculum. The knowledge and skills intended to be learned may not be acquired in full by the student. The effectiveness of the curriculum is itself a product of the curriculum design, quality of teaching and the efforts and abilities of the student. In terms of the technological objectives of the course the student's level of learning may be either 'low' or 'high' and accordingly affect the quality of his or her subsequent vocational performance or vocational preparation (e.g. in the 'awareness' oriented courses).

5.3.2 OPERATIONAL VARIABLES

This group of variables deals with the throughput of students relative to

- demand for participation in a course - the number of individuals potentially or actually seeking to enrol.

- industry's need for the 'product' of the course - the number of individuals, with skills and knowledge of the type in the course, required by industry.

Clearly, student demand and industry need, so defined, may not coincide. Further, the need for the educational product can be expressed in a variety of qualitative and quantitative alternatives, since various parties such as management in industry, sections of its workforce and external but implicated parties (e.g. governments, the unemployed, community action groups, management and workers in other occupations or industries) can see different objectives or different routes to the same objective. For example, to increase production a firm's management might favour technologies which require additional labour with low levels of skill, whereas the middle-level employees might favour technologies which require fewer new personnel but higher levels of skill. Though the two parties could share a desire for increased production, their views on the labour requirements, and hence training need, for that objective would differ. The industrial action of Telecom technicians and the confrontations over the Redfern Mail Exchange are recent examples.

The operational facet of the Department's programme influences the impact of courses through

Table 1 Major variables determining the technological impact of the DTAFE vocational programme

	Curriculum variables							Operations variables		
	Student's vocational objective	Target industry	Target occupation	Learning objective	Effectiveness of curriculum	Technological standard in curriculum		Department's effort (no. of courses, student places)		Efficiency of instruction
						relative to S.A. industry	relative to industry elsewhere	relative to industry needs	relative to student demands	
Alternative states for each variable	vocational awareness	Industry A	occupation a	appreciation of technologies	low	sub-standard	sub-standard	below	below	low
	general preparation	Industry B ⋮ industry Z	occupation b ⋮ occupation z	competence in technologies	high	standard above standard	standard above standard	matching	matching	high
	vocational entry	or	or							
	basic qualifications for entered occupations	industries L-N	occupations l-n					above	above	
	vocational extension	.				leading	leading			

Using the table for descriptions and evaluation

The states for each variable may be identified and plotted on this table, providing broadening pictures of the current technological make-up and impact of the Department's educational provision, successively in terms of

- each topic within a course
- each course within a sub-programme
- each sub-programme in a programme
- each programme in a programme sector
- the sum of educational programme sectors, that is the entire TAFE educational 'programme'.

Equally, desired states can be plotted, defining preferred policy on TAFE technology education at the various levels. Evaluation of current practices can be achieved by comparing the actual and intended configurations.

- the effort in terms of the resources allocated to a course and hence the number of student placements provided in a course.

- the efficiency of instruction, hence the proportion of students who satisfactorily complete the course.

These two variables determine the throughput of students, which in turn can be described in terms of whether the throughput exceeds, equals, or falls short of (a) demand by potential students and (b) industry's need (taken as its capacity for employing people with the particular set of knowledge and skills).

Together the curricular and operational variables determine the size and nature of output from the Department's educational programme. The various combinations of parameters within the table show the vast range of alternative formats which the Department's programme might take. The format which the Department employs for its programme in general and for individual courses, in particular, will cast a particular pattern of influence on aspects of industry and the workforce, such as:

- the technological state of industries

- the productivity and flexibility of existing industries

- the opportunity for generating new industries

- the competitiveness of certain South Australian firms with other South Australian firms in the industry

- the competitiveness of the South Australian industry with its interstate and overseas competitors

- the competitiveness of an industry with alternative industries

- the skill mix of occupations

- the degree to which different sections of the community gain access to the workforce and to particular occupations within it

- the degree to which individual's vocational decisions are well informed

- occupational mobility

That is not to claim, of course, that the educational programme is the sole or most dominant influence in these fields. The key point instead is that the Department's programme can take many configurations each of which selectively promotes certain technologies, and associated socio-economic options. This selectivity arises for several reasons.

First, resource constraints dismiss the apparently ideal situation where all industries, occupations' and individuals' vocational educational requirements are met to the

fullest extent. The costs for a virtually unlimited range of customised courses are prohibitive.

Second, even if this 'ideal scenario' were feasible, its effects still would not be neutral in terms of its impact across sections of the community and industry. For example, if all courses were geared to the 'advanced standard' of technology, they would tend to reduce the existing technological gap between firms now employing older technology and firms now employing the newer technology (to which the courses would be pitched) and now enjoying a competitive advantage because of it.

Third, the impact of the Department's programme depends in part upon the varying receptiveness of the individuals, firms and industries which form the Department's clientele. Some innovative firms and industries not only seek and utilise more technologically advanced skills and knowledge, but also provide a stimulus for the Department to up-grade the technological level of certain courses. However, some conservative firms and industries are unreceptive to technological skills and knowledge more advanced than their current practices. Indeed this conservatism at times acts as a pressure for the Department not to upgrade substantially the technology in certain courses.

Recognition that the Department's programme necessarily has a differential impact across industries or firms or individuals presents technological change as a series of policy questions. For example:

(a) Should the overall balance of the Department's course be pitched at

- the standard level of technology, thereby serving the immediate needs of the bulk of industry?
- the advanced level of technology, thereby helping to draw the bulk of industry into closer competition with the currently progressive SA firms as well as with firms elsewhere?
- the leading level of technology, thereby distancing courses from the immediate needs of industry but perhaps fostering innovation across SA industry?

(b) Given the improbability that the overall programme could be raised to the leading level of technology, which technologies, industries, occupations or student clienteles should be given special attention at that level?

SECTION 6
CONCLUSION

This paper has attempted to show in broad terms how technology is used, developed, taught and promoted by the Department. The Department's role with respect to technological change is two-fold.

First, technology is a key factor in determining the effectiveness and efficiency of the Department's internal operations. In this sense technological change sets two objectives for the Department:

(a) to overcome its inheritance from the seventies, a technological backlog in its infra-structure and instructional processes, and

(b) to maintain the relevance of its curricula.

The make-up of technical skills and knowledge of the Department's staff is a central consideration for both objectives, in terms of the individual teacher or officer and in terms of the range and balance of competences across the Department's workforce.

Second, the Department, predominantly through the format of its educational programme and to a lesser extent through its pattern of consumption and its development of technologies, is itself a key factor in influencing the rate and nature of technological change in the community and industries beyond the Department. It is in this role that technological change must be viewed as primarily a policy issue for the Department and for South Australia as a whole.

In the next paper significant trends and lessons, not confined to South Australia and the Department - are drawn together. They signal some of the profitable directions for the Department's role in the promotion of technology and for technological change within the Department.

PAPER NO. 2

TECHNOLOGY, SKILLED LABOUR AND INDUSTRY: TRENDS AND LESSONS FOR TAFE

This paper outlines local and international trends in industry, employment and technological change which provide cues for the Department's response to technological change. It gives special attention to approaches to vocational education and training.

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SECTION 1
INTRODUCTION

This paper presents a range of concerns confronting governments and education systems as they formulate strategies for dealing with technological change. While providing trends and lessons for the Department of TAFE for its response to technological change, the issues outlined are not peculiar to South Australia and the Department of TAFE but are topical in the national and international arenas. The discussion does not focus on specific technologies or on a technological change as if it were a self-contained phenomenon. It seeks instead to preserve some flavour of the interdependence among technical developments and socio-economic trends.

The intent in adopting this position is two-fold:

- To highlight the societal forces operating upon TAFE systems as they grapple with technological change - a pragmatic objective.
- To promote the notion that technology does not have a will of its own but to a large extent can be controlled - an unabashed, philosophical position.

This approach has stemmed from a belief that some of the all-embracing concepts which we apply to technical or technological change hinder rather than help as in coming to terms with the concrete issues.

The notion of a current 'technological revolution' is the main offender. The expression conveys well the undeniably dramatic impacts of contemporary technical developments on the community, on industry and on the balance between competitors in the world market-place. The highly visible effect of the application of the micro-processor in a vast array of consumer products, services and industrial processes provides a topical examples.

However, the notion of a technological 'revolution' is in another sense quite misleading. It underplays these less dramatic facts.

- Technological change is as commonplace historically as human beings' successful attempts to make different things or the same things in better ways.
- Technological changes more often are the result of an evolutionary process rather than a single and decisive break-through in scientific knowledge. That is, while not down-playing the role of the insightful and inventive mind, new techniques are derived incrementally from previous techniques and knowledge. The micro-processor is a notable example. It evolved through a series of cumulative accomplishments in engineering, science and, not the least, enterprise and not from one, momentous discovery.

- The adoption and application of new technologies tend also to be incremental rather than 'revolutionary'. For example, the now widespread use of computerised numerical control technology throughout manufacturing industry has not occurred as a flash-flood hitting all firms at once and sweeping aside previous technologies. Instead the technology has been taken up progressively - perhaps cautiously at first by the few and then rapidly and extensively by the rest. The eventual impact on industry might well be seen as revolutionary but the process remains evolutionary.

The upshot of this argument is that technological change is not a fundamentally new experience for TAFE systems. What may be novel to TAFE systems is the current rate and extent of technological changes and, importantly, the current and predicted effects of technological change on the workforce in general and on the TAFE workforce in particular.

Within the overall theme that technological change is evolutionary rather than revolutionary, the effect of technological change in TAFE is discussed in three contexts:

- the socio-economic
- the industrial structure of the workforce
- the occupational structure of the workforce.

Some social implications of the TAFE programme are discussed.

SECTION 2

THE SOCIO-ECONOMIC CONTEXT

2.1 THE ECONOMY AND EMPLOYMENT

Worldwide economic growth has declined: the generation and accumulation of national wealth is not increasing at the rates which existed prior to the seventies. There have been no compelling signs for an early and substantial reversal of this trend, although governments, the community and industry may well work towards and live in the hope of general economic recovery.

Unemployment is high, growing world wide and is being compared not only with cyclical fluctuations before and after the Great Depression but also with the Great Depression itself. The level of unemployment clearly is linked to the general economic downturn. However, even in the advent of a resurgence in the economy we can expect - from historical lessons - that an associated resurgence of employment will lag several months behind it.

Technological change is central to this issue. Individual firms, industries and countries are turning towards new technologies in order to preserve or improve their competitive positions in the marketplace. Notably new technologies are selected often on the grounds that they increase productivity per unit of labour (See figure 1 for an example.)

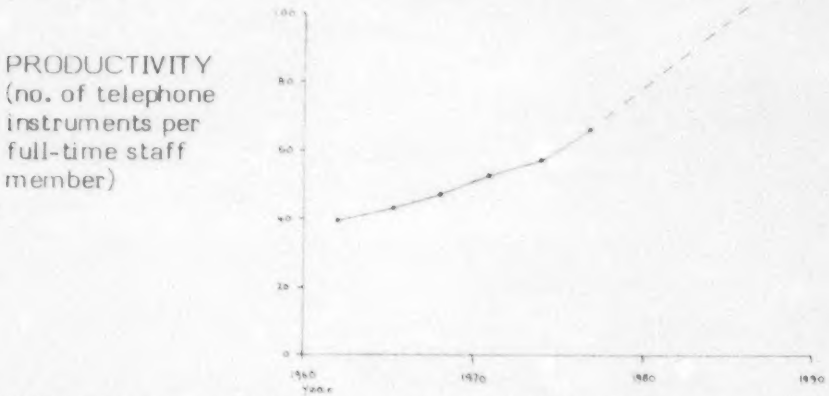


FIGURE 1 Increase in productivity in Telecom (after Commission of Inquiry into Technological Change in Australia, 1980, vol.2, p.395)

Opinion on the nett effect across industries varies. One viewpoint is that a major recovery in the economy will be fuelled by new technologies which will increase overall productivity, and therefore enable gross national product to grow at a rate in excess of the rate of employment generation. That is, although there is a strong connection between the general state of the economy and levels of unemployment, the relationship is not one-to-one: economic recovery appears necessary if unemployment

is to be reduced, but economic recovery alone will not necessarily solve the unemployment problem.

An alternative viewpoint is that, while technological change might reduce levels of employment in some industries, it will also lead to the generation of new industrial activities, consumer demands and employment opportunities. However, this belief appears unduly optimistic in light of some of the more topical 'new' technologies. For example, there has been speculation that whereas industrial robotics and computer technologies will displace jobs in some industries, they will also spawn jobs in other fields (such as the design, manufacture and servicing of computers and industrial robots) to the extent that jobs displaced by the adoption of the technologies will be compensated for. However, the computer and robot industries themselves can be computerised and automated (and remaining labour-intensive processes in those industries can be relocated to countries with cheaper labour).

Similarly, some hopes are pinned upon the possibility that industries adopting new technologies will use the innovations to improve the quality of goods and services rather than to reduce cost per item through labour savings. The use of micro-computers for more effective stock control and accounting in small businesses is a possible example. However, reduced costs and improved quality are not necessarily incompatible.

In sum, the more temperate conclusions which can be drawn are as follows:

- Economic recovery is required if there is to be any chance of the unemployment problem being solved without a deterioration of living standards.
- Technological change is a necessary ingredient for economic recovery.
- Productivity gains through technological change can foster economic recovery without a commensurate reduction of unemployment.

Thus for governments pursuing both economic recovery, in which technological change is an ingredient, and a reduction in unemployment, there appears to be either or both of two strategies:

- policies and mechanisms for converting gains made on the macro-economic front into employment opportunities.
- policies and mechanisms for promoting selectively those types of technological changes which show the greatest potential for generating employment as well as economic activity.

In this context government intervention is centred around which of the strategies should be actively promoted? Two options are manifested in the policies of various governments:

- a broad-front approach where technological change is promoted across industries, without deliberate, selective support for specific industries. Examples include: taxation concessions for equipment updates; the establishment of technology advisory bureaux for industry; sponsorship of education and training in general; and 'across the board' tariff protection for domestic manufacturing industry.

- a selective approach whereby only certain technologies are fostered via regulation or promotion. Examples of regulatory influence include: mandatory, pre-requisite qualifications for entry into selected vocations; specification of product performance such as motor gas emissions; and tariff penalties for foreign competition. Examples of promotion include: incentives in the form of direct sponsorship of industries; infra-structural services such as technology centres; and special-purpose funding for selected training programmes. Bridging the division between regulation and promotion are industries set up and run by government instrumentalities, e.g. public utilities and research and development agencies.

2.2 THE CONTRIBUTION OF EDUCATION AND TRAINING

Education and training can play a significant part in improving the economy and hence assisting to generate employment. A correlation between economic well-being and levels of education and training is evident.

For example, the post-war 'economic miracle' in Germany and Japan has been paralleled by the high levels of education and vocational training in those countries. This emphasis on the development of their human resources is seen as a key factor in their technological and economic development.(1)

Australia, by way of contrast, faces its currently severe economic difficulties with a less well educated and trained population. In terms of participation of 16-18 year olds in full-time education, only five of nineteen O.E.C.D. countries have rates lower than Australia.(2)

A correlation between economic growth and the level of the education and training is evident at the micro as well as the macro levels. For example, since 1960 the rural town of Staples in Minnesota has consolidated and expanded its 'home-grown' industries and attracted many new industries through a programme with a heavy emphasis of vocational education and training. The success of this community in reversing its economic decline has been attributed to a large extent to its newfound capacity to supply local industry with "skilled, dependable labour".(3)

However, while higher levels of education and training tend to correlate with more vigorous and resilient economies, a causal relationship has not been established. That is, it cannot be assumed that 'education produces economic growth'. The more cautious but nonetheless encouraging conclusion which can be drawn is that education and training can contribute significantly to economic recovery when they are provided in concert with complementary measures (e.g., fiscal policy, industrial relations, and the promotion of certain industrial activities). The purpose of the education is to supply to the workforce the technical skills and knowledge required in industry.(4)

This conclusion is shared by industrial and manpower analysts such as Ford and is being reflected in the policies of O.E.C.D. governments.[5] For example, in Australia the platform of the current Commonwealth Government stated in 1983:

> *"A first requirement is appropriate economic policies with particular emphasis on employment generation. Within that context all sectors of education will need to be involved in raising the levels of general education and the skills base of the Australian workforce to underpin the process of economic regeneration."*[6]

Policies with such an emphasis on general economic objectives are being matched by increased governmental promotion of technical and further education.

However, besides their role in aiding general economic recovery by supplying technical skills and knowledge to the bulk of industry, education and training can be used to promote those types of technological change which show the greatest potential for generating employment.

The question of which technologies should receive selective treatment arises. It is proposed that the question is a matter for determination by government as well as TAFE. (Such an arrangement between the Department of TAFE and the Ministry of Technology is presented in paper 3.)

SECTION 3

THE CONTEXT OF THE INDUSTRIAL STRUCTURE OF THE WORKFORCE

3.1 TRENDS IN INDUSTRY SECTORS

Whichever major analytical device is used to classify sectors of industry, the general outcome is the same: the industrial structure of the workforce is changing.

In brief:

- Agriculture and minerals extraction continue their century long trend of employing a decreasing proportion of the workforce. Increased productivity through technological change is a major cause.

- Manufacturing industry appears to have 'peaked' and is employing a nearly static or even declining proportion of the workforce. As suggested above, industry, having divested labour during the current recession, might take the opportunity to switch to less labour-intensive technologies when economic conditions improve.

- Service industry employment proportion shows growth. There is debate over whether or not this trend will be sustained: productivity gains through technological change is the main factor considered likely to arrest the trend.

- The information sector has shown continued growth. Again there is debate over the prospects of this trend continuing, if not in terms of the sector's proportion of the workforce, at least in terms of the sector's ability to absorb labour becoming surplus to the requirements of the other static or declining employment sectors.

- The 'quinary' sector (domestic and quasi-domestic servicing and manufacture) is emerging as a per capita major economic and occupational sector, even though it lies largely outside the 'workforce' as defined in economic statistics. (Unpaid work does not enter figures on Gross National Product, even if its services and products improve quality of life and the value of the national assets and are identical to those which are paid for elsewhere in the economy and hence which are recognised in economists' measures.)

These trends are presenting a major problem for TAFE systems whose resources (especially the structure of the teaching force) are in danger of becoming markedly out of kilter with the broad balance of training needs across industry sectors. This problem, explored by Swain and Cappo (1980), must be dealt with quickly and effectively if TAFE is to contribute usefully to industry in a period of structural change.(7)

Governments worldwide and across the spectrum of political persuasions are attempting to influence the structure of industry. Employment generation is a key factor in governmental policies in this field (although it clearly is often not the only factor, or even the dominant factor, as indicated by examples of government

sponsorship of armaments industries principally in the interest of a nationally self-reliant defence capability).

The industries given selective support by governments vary. (The appendix presents eleven criteria for selecting industries for preferential treatment.)

SECTION 4

THE CONTEXT OF THE OCCUPATIONAL STRUCTURE OF THE WORKFORCE

There is clear evidence that the occupational structure of the workforce is changing, or more accurately, that over the decade it has changed and there are compelling reasons for expecting that the change will continue.

Technological change indisputably has rendered certain types of occupations obsolete and generated demands for new types of occupations. In gross terms we have, for example, a contraction of the employment share now available to tradesperson and process-worker occupations in manufacturing industries such as motor vehicle assembly. In a narrower focus the skills required by people in certain occupations are changing markedly from the traditional patterns: for example, the application of electronics in motor vehicle engines is changing the skill requirements of motor mechanics.

The thrust of the immediate discussion is not to predict the future shape and skill-mix of the workforce. Rather it is to point out that the occupational structure of the workforce cannot be extrapolated with confidence from current trends and from the belief that technological change will dictate fully the occupational make-up of the workforce.

4.1 INDUSTRIAL APPROACHES TO TECHNOLOGICAL CHANGE

To illustrate this point the changes in occupational structure of the workforce as a consequence of technological change is considered within two industrial philosophies.

(a) The limited skill, mass production approach (Taylorian philosophy)

Many Australian, British and American industries (or at least firms in them) have followed a Taylorian industrial tradition - the Henry Ford approach taken to the furthest expression of worker specialisation and 'top end' control. In brief, the operations of a firm are sub-divided down from senior management into successively narrower specialisms for the worker and into the smallest practicable differentiation of steps in the production process. In classic examples - e.g. the Detroit automotive industry - the worker at the bottom of the firm's hierarchy performed but one repetitive, simple task and at a rate beyond his control, set instead by the speed of the assembly line. This segregation of personnel by specialist function militates against

(i) collaborative approaches to problem-solving and product development and

(ii) an individual developing the practical, two-fold understanding of the firm as a system and of one or more specialised operations within the firm.

However, the approach is effective for mass production - large quantitites of products from a narrow product range. It also can respond rapidly to changes in the desired level of production, by

(i) drawing into the firm, when the demand is high, unskilled or low skilled workers who can become operatives quickly and with little training, or

(ii) shedding them when demand falls.

The approach is less effective for the production of consistently high quality products or for developing and manufacturing a broad and flexible range of products.

Technological change in industries operating under a Taylorian philosophy is likely to be guided by one over-riding aim: to increase profitability through increased productivity. Thus when a technological innovation showing promise for reducing production costs becomes available, it is likely to be adopted, irrespective of its adverse effects upon the security and skill requirements of the workers. Indeed, since the philosophy seeks to narrow rather than increase the scope of the operative's functions, de-skilling is likely for some workers.

Here, then, is a situation where the nature of available technology 'determines' the occupational make-up in a firm or industry. The technology is exploited to the limit of its potential for minimising labour costs and, perhaps, the influence of the individual worker.

(b) The high skill approach: some lessons from the post-war 'economic miracles'

In some countries, especially West Germany, Scandinavian nations and Japan, a different industrial philosophy is more prevalent and practised by some of the most successful firms by world standards. The approach has been labelled 'low level competence' referring not to workers with 'a low level of vocational competence' but instead to high competence in the low level occupations. Under this approach the terms unskilled, semi-skilled and skilled are inappropriate. All workers are expected to be skilled and do not have their tasks so finely divided into the 'mindlessly simple' repetition that pins the label 'unskilled' on an operative in Taylorian firms. Their vocational and technological skills and knowledge are deemed a vital asset in terms of the industrial relations and production benefits - especially in terms of product quality, product development and process development - which flow to the firm. Part of the philosophy is that the worker who is closest to a 'meaningful' part of the production process and who has an appreciation of the overall process is

(i) best-placed to identify problems quickly within that part of the process and

(ii) a source of solutions for those problems.

Another ingredient is the presence of a common industrial and technological 'language' which enables personnel from different levels and sections of a firm to pool knowledge and expertise for conjointly solving problems relating to product design, production and industrial relations.

This common language is available partly because the workers in the lower level occupations have received more education and training than those in Taylorian structured industries or, indeed, in Australian industry in general. For example, over 60% of German youth enter apprenticeship training (and under a more diverse and flexible scheme than the systems in Australia and Britain).

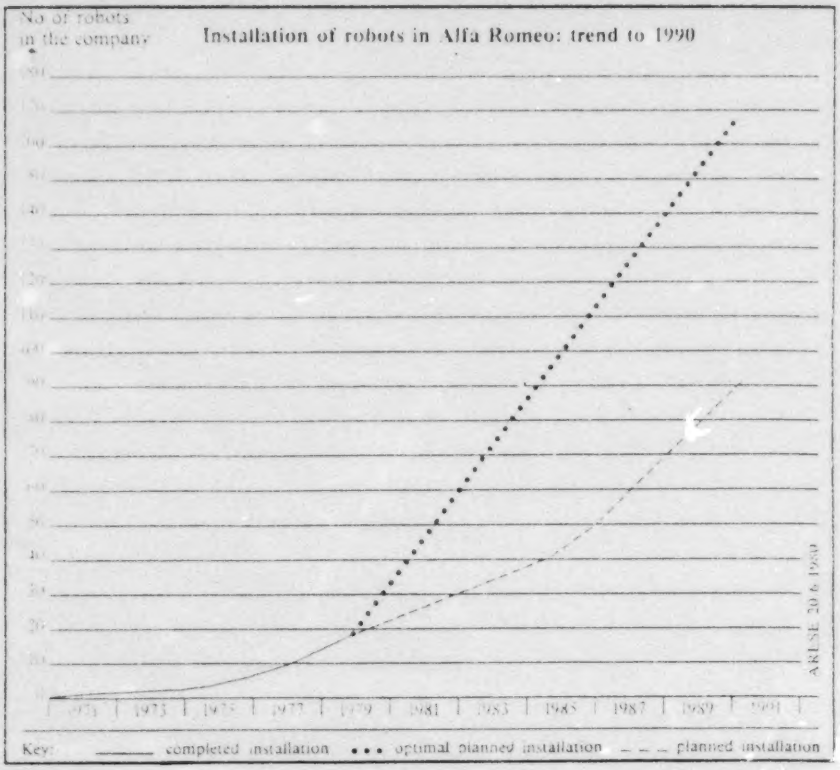


Figure 2: Rate of installation of industrial robots by Alfa Romeo (Pescarollo, p. 18)*

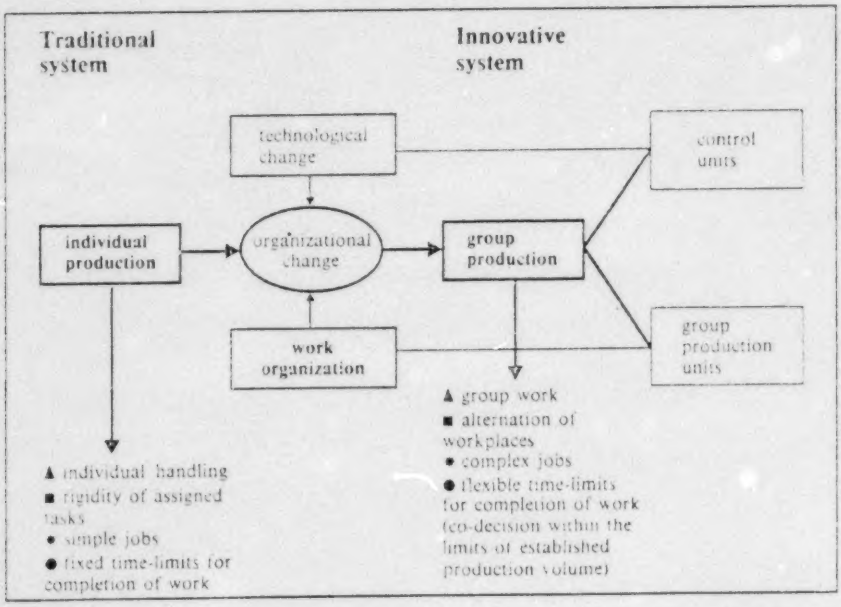


Figure 3: Change from traditional industrial systems to an innovative system during automation by Alfa Romeo (Pescarollo, p. 19)*

*Source: D. Pescarollo (1981), 'The automobile sector: technological development and vocational training' in European Centre for Development of Vocational Training, Vocational Training, Bulletin No. 5, pp. 17-19.

Depending upon the philosophical approach to the organisation of the work pattern, the effect of technological change on occupations can be quite different. Different practical approaches can be taken to the introduction of the new technologies. In this paper the encouragement of the high skill approach is advocated.

A clear example of the high skill approach to technological change is provided by the way in which Alfa Romeo di Arese, Milan, has set about automating its automobile manufacturing operations with industrial robots. The robots have been introduced at a rate deliberately set below the theoretical maximum (see figure 2) so that the firm could concomitantly modify its organisational structure and educate and train its workforce for the new technology and industrial philosophy (see figure 3). The company did not plan to automate all operations to which industrial robots might be applied. The target instead was to automate primarily those processes which previously used heavy, manual labour, which were physically disagreeable or dangerous, or which were repetitive and needed few skills. Workers gradually have trained for occupations geared to processes rather than to a narrow range of specific skills.

Another example is provided by the Lockheed aviation corporation where the programming of machine tools has been placed in the hands of tradesmen-level staff instead of de-skilling those occupations by placing the responsibility with higher level occupations (such as technicians).(8)

These philosophies highlight three key propositions with implications for the occupational structure of the workforce:

(i) Frequently, various technologies can serve the same function. Therefore choices between alternative technologies can be made.

(ii) The introduction of a given technology can be controlled in terms of

- the extent of its adoption
- the rate of its adoption
- the nature of the other technologies and industrial initiatives packaged with it.

(iii) Technological change can lead to various, alternative requirements for skilled labour. This view has clear implications for TAFE institutions as they attempt to plan their vocational programmes in such a way that they provide the community with the mix of skills and knowledge required in industry.

These propositions are the basis of a central theme in this paper, namely, that technological change is to a considerable extent controllable and dependent on human choices, even alongside the imperative to up-grade the technical level and competitive position of industry.

4.2 FORECASTING OCCUPATIONAL STRUCTURES AND DEMAND FOR TRAINED LABOUR

If the numbers and types of skilled labour which will be required by industry in the future were known, planning could proceed accordingly. This desire to see into the future is close to the hearts of governments, job-seekers, the employed, industry and educationalists. It has led to the development and use of manpower forecasting technologies, analogous to weather forecasting and plagued with the same problem: a complex, dynamic system whose past behaviour can be understood with some confidence, whose behaviour tomorrow is reasonably predictable and whose behaviour exactly a year away can be depicted only in terms of gross probabilities.

In any circumstances manpower forecasting is a very uncertain science. Unlike physical systems, such as weather, complex human phenomena are beguiled by the 'human coefficient' whereby people continually generate new causes and directions for their own behaviour. This point was illustrated in the previous discussion which stressed that (a) the nature and direction of technological change are not pre-determined but are the products of human decisions, and (b) those technological choices differentially affect the structure of the workforce. Quite simply, the technological future of a nation arises from choices between options. Unless the principles and goals underlying those choices are understood now, we have little chance of predicting that technological future and hence the pattern of occupations in that future. That understanding is lacking to varying, but considerable extents in most countries.

It is not surprising, therefore, that in general the predictive models for manpower supply and demand have failed to provide forecasts which are sufficiently long-term and accurate for institutions to plan confidently the precise vocational format of education and training programmes or for individuals to plan confidently their careers. Thus observers in the OECD and elsewhere are asserting that manpower forecasts should not pre-determine the nature of vocational education, i.e. by dictating pre-specified numbers of individuals to be trained for pre-specified numbers and types of occupations.(9)

That is not to say, however, that planning of vocational education should dismiss manpower forecasts in toto. In certain circumstances its accuracy is acceptable. For example, it can identify occupations which clearly are vanishing and therefore tell vocational education 'what not to do' and in a more positive vein there are occasions where governments and corporations enter binding agreements for development projects whose labour requirements are identified well in advance.

The conclusions for TAFE are as follows:

- the programming of vocational education cannot be based solely on predictive models of skilled-labour supply and demand.
- consequently, other models or policy-based decisions for programming are required.

While these conclusions are well understood in many areas, they deserve re-stating because there is a danger that unduly optimistic faith in forecasting models might be resurrected as education systems grapple with the problem of identifying skill changes generated by technological change.

If manpower supply and demand modelling cannot provide the full template for TAFE programming, what alternative strategies are available?

It is proposed here that a three-part approach can provide the answer:

- partial reliance on forecasting, i.e., only insofar as the forecasts provide gross trends rather than specific numbers of placements in all vocational courses.

- regard for vocational education market forces, not just for labour market forces. That is, the shape of the vocational education programme can be strongly influenced by the types of courses demanded by those candidates for vocational education who can illustrate capability to achieve.

  This approach (adopted in Canada) is essentially responsive rather than anticipatory and requires the individual, as well as TAFE, to assess the local labour market in terms of his or her inspirations, and to make a vocational choice to which the educational system responds.

- government policies, which might for example, be intended to promote certain industries by training numbers exceeding present levels of skilled labour demanded by industry.

4.3 SELECTED TRENDS

The previous discussion warns TAFE against relying too heavily on labour forecasting and on assumptions that the nature of new technologies pre-specifies skilled-labour requirements. Nevertheless some trends associated with technological change are becoming apparent. While there is no intention here to imply that these trends are becoming universal throughout the workforce, they nevertheless appear likely to become widespread in some sections of industry to the extent that they should be addressed within TAFE programmes.

4.3.1 INCREASED VOCATIONAL MOBILITY

Under the combined pressures of economic recession and technological change, jobs are variously lost, changed or created. These events lead to increasing frequencies of career discontinuities and of the movement of individuals from one type of occupation to another, not necessarily vertically but often horizontally. Some predictions are that the 'average' person will change vocations several times in his or her working life, moving into jobs in fields related to their initial occupations or even into markedly different fields.

To cater for increased career discontinuities and job mobility the following developments have become topical in TAFE systems.

- recognition that one-off vocational education and training are no longer to be the prevalent option: recurrent vocational education or retraining (whether radically or incrementally) is likely to be more common.

- broad based and flexible education and training for entry into vocations.

The main reason is that these developments allow the student to delay his choice of a specialised vocation until late in his course of instruction. This delay enables the student to make the choice from a position more informed in terms of his or her interests and aptitudes and in terms of the job opportunities immediately after the course.

These developments are consistent with the 'high skill' approach which was discussed above and which is the approach favoured in this paper.

4.3.2 INCREASED BREADTH OF SKILLS WITHIN OCCUPATIONS

Yet another trend related to occupational structure is emerging. It refers to the skill mix of the worker irrespective of vocational changes, particularly in those industries using the high skill approach. In these occupations technological change is leading to an increasing need for labour with a broad range of knowledge and skills rather than narrow specialities.

For example, much engineeering plant now contains integrated systems of hydraulic, pneumatic, mechanical, electrical and electronic technologies. The worker who operates or maintains the plant no longer can get by just with knowledge and skills, even if highly developed, in one of those fields. Instead the worker requires

- at least an appreciation of the other technologies, especially where they 'interface' with the technology in his or her area of speciality.

- possibly some competence in the other engineering technologies.

Similar examples are becoming increasingly prevalent in automotive maintenance as vehicles become more sophisticated, incorporating technologies from fields outside that of traditional automotive mechanics.

The upshot is this: industrial applications of new technologies are requiring system-level skills and knowledge. This trend has implications for all occupational levels. For example, the low level occupations require the worker to have an appreciation of several technologies even though they might continue to operate (with technological competence) in only one area of specialty. For the middle and higher level

occupations there is a growing need for workers with high levels of knowledge and skill across several technologies. This development has given rise to the concept of the 'super technician' or 'systems technician' trained to the extent of the post-graduate, disciplinary expert but in a set of fields each formerly the traditional and separate province of specialised, apprentice-trained workers.(10)

4.3.3 CHANGES IN THE LEVELS OF SKILLS WITHIN OCCUPATIONS

Technological change in some industries may lead to a reduction in the proportion of low skill-level occupations relative to the middle and high level occupations. Emery has illustrated this point, using British data, by comparing the occupation composition of two sections of engineering industry, namely

- car manufacturing, taken as an example of 'technology of the past', and
- electronics capital goods, taken as an example of 'technology of the future'.(11)

The different occupational structures are shown in table 1.

Table 1
Percentages of occupations at different levels in two industries

Occupation	Occupational composition of two industries	
	Car manufacturing	Electronic capital goods
Professional, admin., clerical, managerial	21%	57%
Skilled, Foreman	27%	27%
Semi-skilled	52%	16%

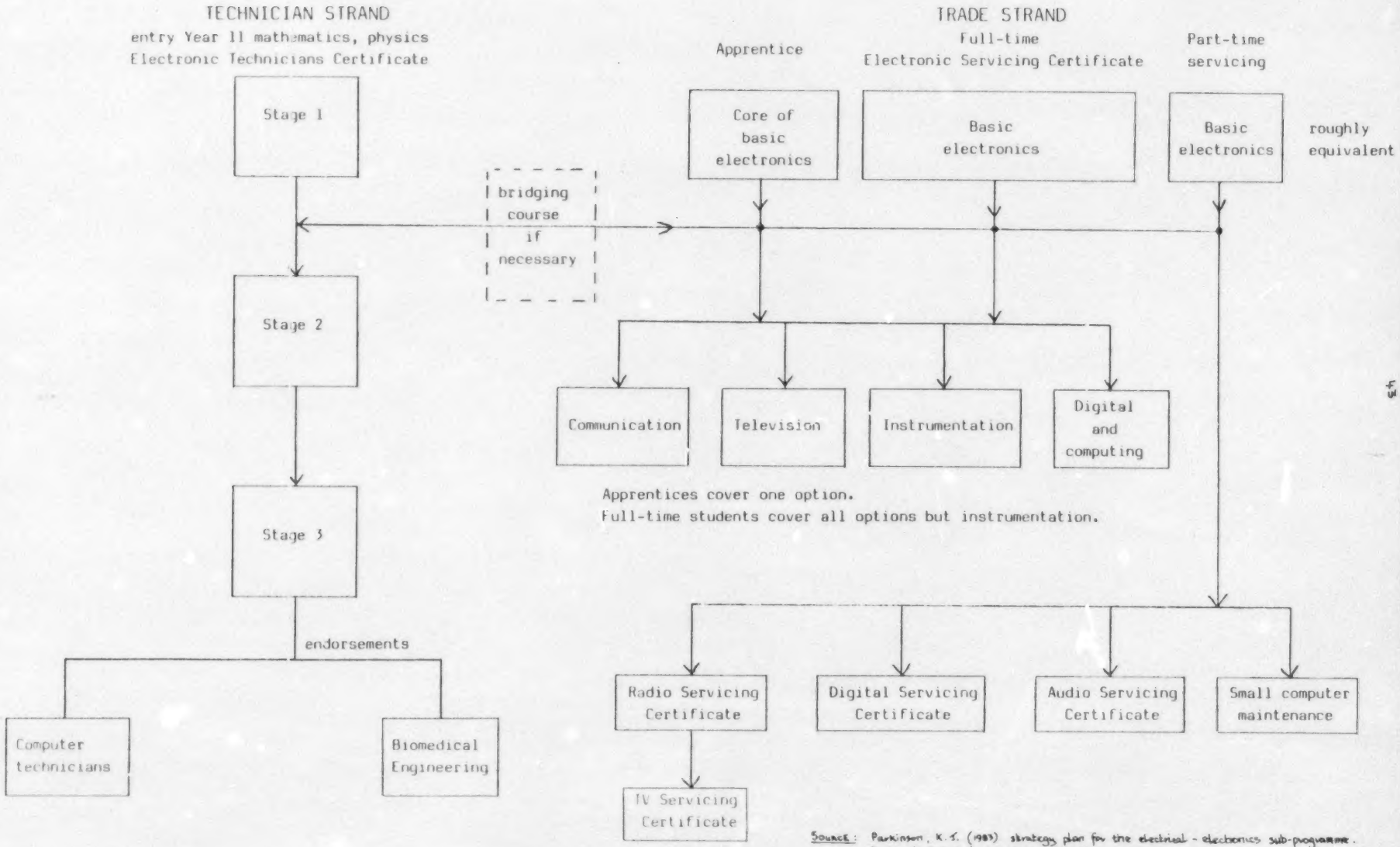
The extent of this trend throughout industry will depend upon the approach directing the choice and implementation of technological change. If the high skill approach is used, TAFE can respond by helping to lift the skills of the workforce in general, and particularly of those people who are currently employed in lower level occupations which may disappear as a result of technological change.

4.4 EXAMPLE OF A TAFE RESPONSE TO THESE TRENDS

The problem which TAFE must address is that its training must be both broad enough and at levels which make the graduate effective in the workforce. An example of a

FIGURE 4. ELECTRONICS SUB-PROGRAMME

Course Schema



Source: Parkinson, K.S. (1983) strategy plan for the electrical - electronics sub-programme. Dept. of Technical and Further Education, South Australia.

current TAFE response to that problem is shown in the proposed amendments to the electronics sub-programme at both the trade and technician levels. (See Fig. 4).

Under a review of training in the electronics field a proposal for courses comprising a common core and subsequent specialised options has been developed. The criterion for determining which skills and knowledge are included in the core units is that those elements which comprise the core are the more enduring 'basics' which change only slowly or infrequently. The elements in the subsequent specialised options are then selected on the basis that they are more susceptible to rapid changes in the application of the technology. As these applications change the content of those options can be revised quickly, without necessitating major changes to the common core.

It therefore should be possible for an individual to up-date skills or change specialisation by returning to TAFE and receiving the appropriate training. By continually adjusting selected parts of courses in order to maintain the technological relevance of the curriculum, the individual whose skills are in danger of becoming dated can be accommodated.

SECTION 5

IMPLICATIONS FOR THE TAFE WORKFORCE

Individuals working in TAFE are subject to the same trends manifested in other sections of industry - the loss, change or creation of occupations. This reality is being recognised in TAFE systems and various responses are being mounted or voiced:

- the need for making new appointemnts on the basis of competence in up-to-date technologies, particulalry in more than one field of application.
- staff development (e.g., through recurrent education, staff rotation and promotion structures) for developing up-to-date competence in more than one field of vocational specialisation. This allows for more flexibility in staff deployment.
- staff development for enabling staff to change occupations.
- the use of limited tenure appointments.
- the use of part-time, temporary instructors (released from industry).

For these initiatives to be effective a systematic and courageous approach to them is essential. Without such an approach, severe problems will beset TAFE: growing obsolescence in the areas of vocational specialism of many teachers; increasingly apparent deficiencies in the technical skills and knowledge of officers in all levels of the administrative and support sections; and a self-destructive complacency about or even disdain for technology. Problems such as these were predicted earlier by Swain and Cappo (1980).

Such a systematic and courageous approach should ensure that the response by TAFE to technology change will be incisive and beneficial to the community at large and to the TAFE workforce.

SECTION 6

SOME SOCIAL IMPLICATIONS OF TECHNOLOGICAL CHANGE AND THE RESPONSE OF TAFE

The previous discussion has focussed on vocational education and its contribution to technological change and to industry. This section broadens that perspective by identifying three important social effects of TAFE programmes.

6.1 RE-DISTRIBUTION OF EMPLOYMENT IN THE COMMUNITY

Education and training are playing a major part in adjusting the shares of the unemployment burden carried inequitably by different sections of the community. For example, government in several OECD countries have mounted special transition education or skill-training programmes to reduce the disproportionately high levels of youth unemployment relative to other age-groups. Similar governmental initiatives have been directed towards elevating the vocational prospects of other groups over-represented in the unemployment statistics - e.g., women, new arrivals and the physically impaired.

These initiatives usually are not expected to reduce the overall level of unemployment but are intended to re-distribute the share of available employment more evenly across different sections of the community. They are manifestations of 'affirmative action' or 'positive discrimination' policies which endeavour to tilt deliberately the scales to a fairer balance point among sections of the community.

6.2 EDUCATION AS AN OCCUPATIONAL ALTERNATIVE

Governments have seen education and training as an activity which is worthwhile in its own right and gainfully occupies the time of individuals who otherwise would be seeking work. That is, education and training can reduce the overall level of involuntary unemployment in that those people engaged in education are temporarily unavailable for work in its usual sense. This outcome is seen as one benefit of increased retention rates in secondary schooling and increased participation rates in TAFE programmes, especially full-time courses.

6.3 EDUCATION FOR OCCUPATIONAL ALTERNATIVES

Some governments, in recognising that many individuals may deliberately or involuntarily not hold a job, see a role for education in providing those individuals with knowledge and skills for activities alternative to paid employment. Education providing 'life-skills', 'survival skills' 'house-holder skills' and 'do-it-yourself' skills can help those individuals to engage subsequently in activities which supplement or substitute for conventional employment. Here the emphasis is not so much on occupying people's time (as in 6.2 above) but rather on enabling them to undertake activities which off-set the material and financial limitations resulting from the lack of a 'normal' job's income.

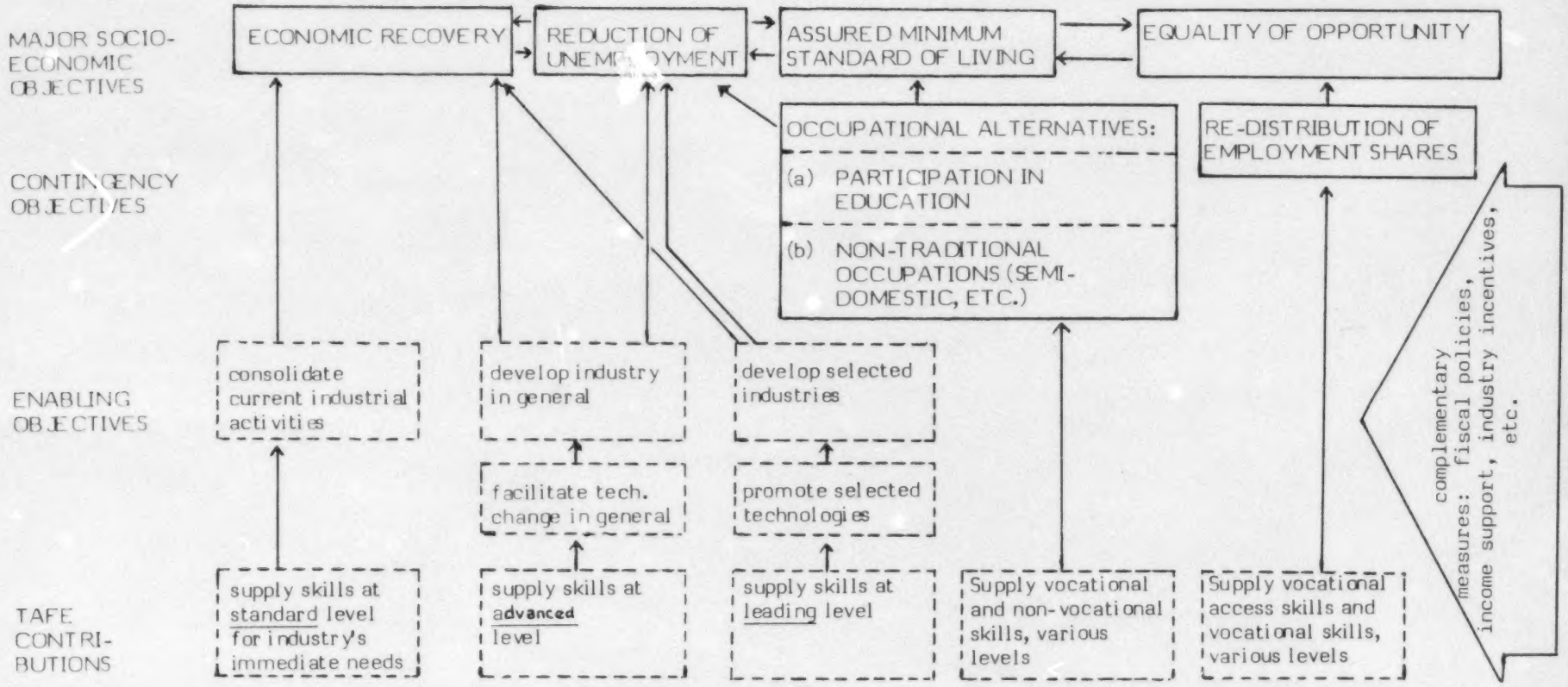

MAJOR SOCIO-ECONOMIC OBJECTIVES
CONTINGENCY OBJECTIVES
ENABLING OBJECTIVES
TAFE CONTRI-BUTIONS
ECONOMIC RECOVERY
REDUCTION OF UNEMPLOYMENT
ASSURED MINIMUM STANDARD OF LIVING
EQUALITY OF OPPORTUNITY
OCCUPATIONAL ALTERNATIVES:
(a) PARTICIPATION IN EDUCATION
(b) NON-TRADITIONAL OCCUPATIONS (SEMI-DOMESTIC, ETC.)
RE-DISTRIBUTION OF EMPLOYMENT SHARES
consolidate current industrial activities
develop industry in general
develop selected industries
facilitate tech. change in general
promote selected technologies
supply skills at standard level for industry's immediate needs
supply skills at advanced level
supply skills at leading level
Supply vocational and non-vocational skills, various levels
Supply vocational access skills and vocational skills, various levels
complementary measures: fiscal policies, income support, industry incentives, etc.

Figure 5. Summary of contributions of TAFE to major objectives in the economic and employment fields

SECTION 7

THE TOTAL ROLE OF TAFE IN AN ERA OF TECHNOLOGICAL CHANGE

Figure 5 summarises the previous discussion of the various contributions of education and training to major socio-economic objectives. It comprises a process model from the perspective of TAFE and also draws on the notions of different levels of technical skills and knowledge as discussed in the previous paper (below standard, standard, advanced, and leading, all defined in terms of technology used in local industry).

From the figure it can be seen that in relation to economic and employment problems, TAFE contributes in five main ways. Both the overall extent of TAFE provision and the balance of that provision over the five elements are crucial policy questions determining the impact of TAFE on socio-economic well-being. Indeed the question of balance is not one that can be solved simply on the grounds of 'meeting expressed demands' since the provision of advanced and leading level skills is a pro-active rather than responsive action. Equally, education directed towards non-traditional occupations and certainly towards the re-distribution of employment shares is a matter for social policy rather than decisions solely based on considerations of educational theory and demands voiced by sections within the community.

APPENDIX

CHARACTERISTICS OF INDUSTRIES GIVEN SELECTIVE SUPPORT BY GOVERNMENTS

The industries receiving selective support by governments appear to have one or more of the following characteristics:

(i) Role in national security and defence, such as the armaments and communications industries.

(ii) Essential services and utilities, such as medical services and energy commissions.

(iii) Emergent or 'sunrise' industries whose development promises either access to opening internal and external markets or at least a hedge against the heavy inroads that imported products would make on the domestic market.

(iv) Geographically advantaged industries which by virtue of the special mix of local resources give those industries an advantage over

either (a) their competitors located elsewhere
or (b) alternative industries which might be sited in the same locality.

South Australian examples include a high technology firm which chose to relocate from the U.S.A. to Adelaide because of the city's preferred 'life-style' for the firm's workforce and because of its infra-structural qualities (such as the new Technology Park and the presence of specialist technical resources in the local, higher education institutions).

(v) Transportable industries which do not depend on special, geographical resources and therefore may be either established in or transferred to communities or regions in need of industrial development. Industries which are labour-intensive and whose raw materials and final products do not incur heavy transport costs are candidates. South Australian examples include the establishment of a government run clothing factory at Whyalla and the decentralisation of some public administration services from Adelaide into provincial towns.

(vi) High export industries such as the white goods and motor vehicle industries successively promoted and exploited in South Australia during the Playford era. As transport costs rise industries whose products have high added value per unit mass are prime candidates. Micro-electronics is a clear example and has been exploited successfully by Asian countries exporting electrical goods.

(vii) High added-value industries, which generate a high level of domestic, economic activity during production. Industries or firms whose products are 'up market' are examples. At the opposite pole are the extraction export industries (raw mineral exporters, live stock exporters) whose products are the feed stock for high added value industries (e.g. manufacturing) beyond the domestic economy.

(viii) Labour-intensive industries Catering, live entertainment and elements of the tourism industries which rely on personal service are obvious examples.

(ix) High technology industries which develop a national expertise in those leading edge technologies linked closely to scientific research. Micro-electronics, aero space, materials science and bio-technology are examples.

Some of these industries may be 'sunrise' industries (e.g. industrial applications of genetic engineering) whereas for a particular country they may represent the adoption of technologies previously established in other countries. The Australian development of V.L.S.I. micro-processor designs is a notable example. The benefit of these industries may not necessarily lie in their direct contribution to employment or their immediate economic pay-off. Rather it may lie in indirect influences - upon spin-off technological developments for other industries and upon a country's 'technological readiness' - a capability enabling opportunities for new markets to be exploited as they arise.

(x) Promotion of domestic, industrial independence Domestic industries which rely on products and services provided by foreign suppliers can be limited by problems of product supply, product range and maintenance services at the discretion of the suppliers and intermediaries. Governments at times promote a domestic alternative to the external industry in the interests of increasing the independence of domestic industries using the goods for services. Defence industries are the most obvious examples. Again, Japan's development of a capacity to produce micro-processors is a telling example: the capacity reduces the vulnerability of the substantial Japanese micro-electronics industry to foreign suppliers of key electronic components.

(xi) Small businesses which can be considered the experimental seed-beds for new industries. In the U.S.A. for example, the firms which show the most rapid growth tend be small businesses, set up either 'from first principles' or by 'hiving off' from larger firms. The promotion of small business therefore is seen as a means of fostering entrepreneurial initiative. In this regard it is notable that the French Government has made dole payments available to those unemployed who wish to set up their own businesses. Similarly in many countries governments have set up advisory bureaux and other supportive measures for assisting small businesses, especially new ones.

END NOTES

1. See Ford, G.W., (1982a) Japan as a Learning Society, mimeographed paper, University of New South Wales, Ford, G.W., (1982b) 'Human Resource Development in Australia and the Balance of Skills', Journal of Industrial Relations, September 1982, pp. 443-453,

   and Limprecht, J.A., and Hayes, R.H. (1982), 'Germany's World-class Manufacturers', Harvard Business Review 60 (6) pp 137-145.

2. 1976 figures from OECD, Education Statistics in OECD Countries (1981), presented also by P. Karmel in Education in the Eighties (Frank Archer Memorial Lecture, 23 June, 1981).

3. Lunde, D.R. (1980), The role of vocational education in the economic development of rural areas: implications for research and development, Educational Research Information Clearinghouse, ED-189-475.

4. See, for example, Ford (1982a, b) op. cit., and Pankhurst, K. (1982), Future Priorities for TAFE, 'International Developments in Skills Training', in TAFE Council of the Commonwealth Tertiary Education Commission (1982) Future Priorities for TAFE in Australia, Vol. 1: (report on the National TAFE Conference 29 August, 1982 - 2 September, 1982) pp. 12-30.

5. See Ford (1982a, b) op. cit. and Pankhurst op. cit.

6. Australia Labor Party (1983), Education: Investing in the Future, mimeographed copy of policy released before the 1983 national election, para. 4.4.

7. Swain, R. and Cappo, J. (1980), The effect of technological change on TAFE, Department of Technical and Further Education, Adelaide.

8. Royal Melbourne Institute of Technology (1980), Technological Change and Vocational Training: a report on aspects of technical and further education, R.M.I.T., Melbourne.

9. See Pankhurst (1982) op. cit. and Thorogood, R., 'Current Themes in Vocational Education and Training Policies', Industrial and Commercial Training, Vol. 14 (10), pp. 328-331.

10. Royal Melbourne Institute of Technology, op. cit.

11. Emery, F. (1980), Impact of Technology on Society, paper presented at the Thredbo Conference (28-30 May, 1980) of the Australian Capital Territory Secondary Principals' Council.

PAPER NO. 3

PROPOSED RELATIONSHIPS BETWEEN THE DEPARTMENT OF TAFE AND THE MINISTRY OF TECHNOLOGY

This paper is the third in the series on the technological issues confronting the Department of TAFE and South Australia. The newly established Ministry of Technology presents a focus and ally for the Department as it responds to technological change. The paper, which was prepared for the Ministry, suggests functions which relate to both bodies and which might be performed to their mutual advantage.

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SECTION 1
INTRODUCTION

Under the worldwide pressures of recession and technological change communities faring best are those which have placed at a premium the development of their 'human resources'. Vocational knowledge and technical skills are major ingredients. In its role as the Government's main instrument for providing education and training to the State's youth and adults, the Department of TAFE is therefore strategically placed to influence the technological, economic and social directions of South Australia. While technological change is presenting the Department with promising opportunities, it also presents challenges of great complexity and difficulty.

In any event the most beneficial impact of the TAFE educational programme cannot be achieved by the Department in isolation. The Department therefore welcomes a close association with the new Ministry of Technology. This paper suggests ways in which that association might profitably be forged. The next section outlines major tasks confronting the Department and relating to the Ministry of Technology, after which some functional relationships between the two parties are proposed.

SECTION 2

MAJOR TASKS FOR D.TAFE - FROM A TECHNOLOGICAL VIEWPOINT

2.1 THE RANGE OF TASKS

The major tasks currently being addressed by the Department can be classified under three headings:

(a) the provision of technological knowledge and skills through the D.TAFE educational and training programme,

(b) the use of technology in the teaching-learning process (especially in terms of equipment, materials, methods and teachers' technical expertise), and

(c) the use of technology in the Department's infra-structure (organisation, administration, support services and accommodation).

The Ministry can play a valuable role in each area. However the following discussion concentrates on the first area - the technological content of curricula and the structure of the educational programme. The reason: ***it is in this area that the Ministry might enter a unique kind of relationship with the Department of TAFE.***

2.2 KEEPING VOCATIONAL EDUCATION ABREAST OF LOCAL INDUSTRY

The technologies used by industry vary throughout industry. Thus in the South Australian context technologies can be described in terms of their technical superiority and extent of adoption in S.A. industry. A given technology (or the technological content of a D.TAFE course) can be rated at any of four levels defined thus:

(a) Leading: the technology is ahead of even the most competitive firms in South Australian industry.

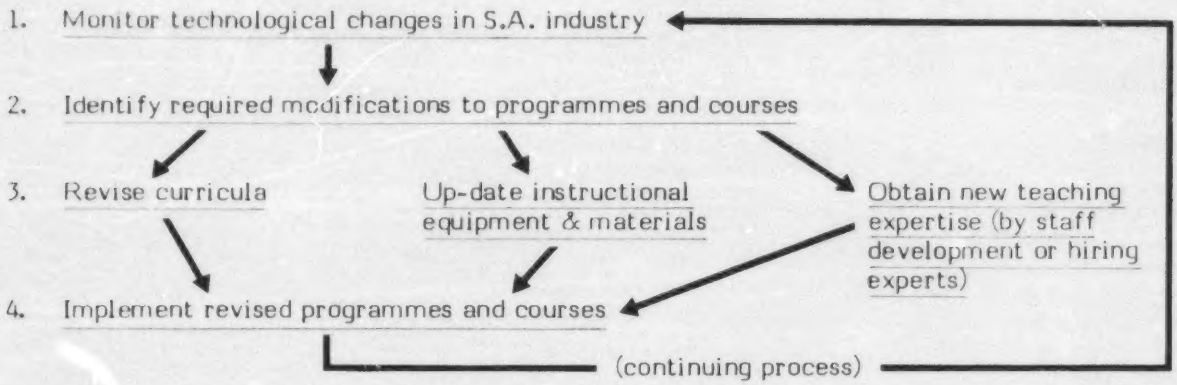
(b) Advanced: the technology is used by some firms but is ahead of most of the local industry.

(c) Standard: the technology is employed by the majority of firms in the local industry.

(d) Below Standard: the technology has been superseded in most local firms.

Technology used in industry changes over time. The changes generally are incremental - evolutionary rather than revolutionary. The Department therefore endeavours to stay abreast of the changes by continuously up-dating its programme.

The strategy used by the Department is as follows:


1. Monitor technological changes in S.A. industry
2. Identify required modifications to programmes and courses
3. Revise curricula
Up-date instructional equipment & materials
Obtain new teaching expertise (by staff development or hiring experts)
4. Implement revised programmes and courses
(continuing process)

The approach is essentially responsive to local technological change rather than anticipatory or pre-emptive. At any time the balance of the Department's programme is pitched at about the **standard level** of technology. Keeping the balance at even this level is a major task given (a) the breadth of the educational programme, (b) the rate of technological change, and (c) resource implications.

To improve its capacity to keep up-to-date, the Department is currently

- developing more frequent and effective curriculum review procedures
- exploring the use of simulated and general training equipment rather than the more inflexible and expensive equipment as used in industry
- increasing the equipment budget
- piloting joint use of equipment with industry
- increasing staff development (technical update) initiatives.

Depending on the success of these initiatives the Department (a) should stay abreast of technology at the **standard level** and (b) perhaps shift the balance of the programme towards the **advanced level.** If the shift occurs (and there is no certainty) the effect would be significant: a facilitation and perhaps a stimulation of technological change across the bulk of industry.

The Ministry of Technology can play an important role in these initiatives as a contributor of information and advice and as a recipient of information gained during the Department's curriculum reviews.

2.3 SELECTING TECHNOLOGIES FOR SPECIAL PROMOTION

Leading level technology has been promoted in a few, selected areas of the Department's programme.* For example, in the seventies the Department helped to introduce computerised numerical control (C.N.C.) technology to South Australia. Industry sent personnel to TAFE not only to acquire operational, technical skills but also,

(a) to evaluate the potential of C.N.C. for their firms and

(b) to use TAFE as a technical consultancy, assisting firms to solve practical problems associated with the adoption of the technology.

Thus when dealing with selected **leading level** technologies the Department requires access to specialised, industrial equipment (rather than, say, simulators) to encompass the evaluative and advisory/trouble-shooting roles. This practice is reflected in the current scheme whereby The Cadds Man firm and the Department have arranged joint use of the firm's modern CAD/CAM equipment.

Through similar projects the Department can continue to contribute towards industrial innovation in South Australia. However the Department does not envisage shifting the balance of its programme beyond the **advanced level** to the **leading level** of technology. The costs and effort appear prohibitive. Also the programme would become too distanced from the types of technical skills required for industry's more immediate needs. The problem therefore is one of deciding which technologies and industries will receive special attention in the Department's programme.

In the examples of C.N.C. and CAD/CAM technologies the Department's decisions were anticipatory, rather than responsive or pre-emptive. It seemed inevitable that these technologies eventually would be adopted by S.A. industry irrespective of the TAFE projects. However even in these cases the initiatives can be seen as Government policy which differentiates between technologies and selectively promotes certain technologies and industries.

The selection of leading level technologies for attention in the TAFE programme should be a major point of Government policy on technology. The Ministry of Technology therefore can be a source of policy on leading level technology projects for the Department of TAFE. It is suggested, however, that scope for TAFE staff to initiate consideration of technologies for special treatment should be preserved: the C.N.C. project arose because of the ingenuity of staff who themselves converted their advanced level N.C. equipment to leading level C.N.C.

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* It is stressed that in this role the Department does not attempt to duplicate the roles of the universities, CAE's or the S.A. Institute of Technology. The Department is concerned instead with industrial applications of available technology requiring skills at an academic level below that provided by the higher education sector.

SECTION 3

PROPOSED RELATIONSHIPS

Table 1 outlines six important functions which might be performed by the Ministry of Technology and which relate to the Department of TAFE. It suggests roles which the respective bodies might play in relation to the functions. The table does not provide mechanisms for achieving the co-operative association. However, general mechanisms can be proposed:

- a systematic exchange of information
- consultation
- joint representation on advisory/policy committees (e.g. the Ministry of Technology represented on the D.TAFE Council; DTAFE represented on the S.A. Council on Technological change.
- personnel exchange (secondments and joint participation in task-force groups for special projects).

These mechanisms should readily forge a partnership between D.TAFE and the Ministry of Technology under the beneficial circumstance of the Minister's portfolio embracing both bodies.

TABLE 1 : SUGGESTED MAJOR FUNCTIONAL RELATIONSHIPS BETWEEN MINISTRY OF TECHNOLOGY AND DEPARTMENT OF TAFE

POSSIBLE FUNCTIONS OF MINISTRY	ROLE OF MINISTRY OF TECHNOLOGY	ROLE OF DTAFE	RELEVANT SECTIONS OF TEXT
A. FORMULATION AND DISSEMINATION OF POLICIES REGULATING OR PROMOTING TECHNOLOGIES A1 policies for S.A. Govt instrumentalities A2 policies for S.A. industry and community	. Responsibility for policy formulation and dissemination especially for leading level education/training by D.TAFE . consult with DTAFE on policies directed to (or otherwise affecting) TAFE training/education	. implementation of policies requiring TAFE action . consultative and advisory	2.2 2.3
B CO-ORDINATION OF JOINT PROJECTS ON TECHNOLOGY (eg. inter-departmental; gov.-industry; cross educational sectors)	. Responsible for co-ordination . consult and advise DTAFE on projects relating to TAFE operations	. consultative and advisory esp. on training implications and options	
C MONITORING TECH. CHANGE C1 Tech. used in S.A C2 Tech. not used in S.A. but available C3 Tech. under development in S.A. C4 Tech. under development beyond S.A. C5 Social, economic impact	. General responsibility for co-ordination of C1 - C5. . Specific responsibilities for monitoring C2, C3, C4, C5 and areas of C1 complementing D.TAFE role. . inform DTAFE	. specific responsibility for aspects of C1 in D.TAFE vocational fields (via curriculum reviews); main focus on standard level technology in S.A. industry . inform Min. Tech.	2.1
D EVALUATION OF TECH. OPTIONS D1 Technical quality, especially for industrial applications D2 Socio-technical systems (includes social impact)	. General responsibility for co-ordinating D. Special responsibility for (a) D.1 complementary to D.TAFE role (b) D.2 . Inform, advise DTAFE	. specific responsibility for selected aspects of D.1, in terms of technology within TAFE vocational fields . inform, advise Min. Tech	2.2 2.3
E CLEARINGHOUSE - INFORMATION SERVICE ON TECHNOLOGY	. Establish clearinghouse . Supply of accessioned information . consult with DTAFE on clearinghouse design	. consult Min. Tech. on clearinghouse design and links with the TAFE clearinghouse system (developed by D.TAFE) . provide appropriate data for accessioning into clearinghouse	
F PUBLIC EDUCATION ON TECHNOLOGY	. Responsible for general publicity on tech. and tech. policy	. consultative and advisory . specific responsibility for publicity and education related to TAFE programmes	